



Lean Six Sigma Green Belt Skill Set Healthcare





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LSSH Green Belt Skill Card v1.1

ECQA - European Certification and Qualification Association

LSSA – Lean Six Sigma Academy.

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1 Introduction

1.1 LSSA - Lean Six Sigma Academy

It is important for businesses and organisations to continuously focus on customer satisfaction by supplying products or services with outstanding quality, cost efficiently and within the agreed lead time. Improving quality and efficiency is the domain of ‘Process Improvement’.

Realising these objectives is effectively achieved by applying Lean Six Sigma: a combination of Lean Manufacturing and Six Sigma approaches. Both management strategies are well established with proven success and are among the most applied process improvement methods in the world. Lean Six Sigma is a clear, practical and structured method to reduce lead times, production losses, quality complaints and operational expenses.

Within Lean Six Sigma, individuals can be trained at various ‘Belt levels’. These levels are called Black Belt, Green Belt, Orange Belt and Yellow Belt.

Belt level	Vocational Education Training	Adult Education – Job roles
Yellow Belt	Initial VET secondary level	Direct patient care providers
Orange Belt	-	Direct Care providers, Health Care assistants (HCA’s), Nurses, Lean Facilitators, Supervisors
Green Belt	Higher Education	Clinical Nurse Manager, ward and unit managers, Clinicians
Black Belt	-	Clinicians, Unit Managers, Project Managers, Management, Consultants

The LSSA – Lean Six Sigma Academy – was established in September 2009 with the main objective to determine a common certification standard for Lean Six Sigma job roles. This has been realised by developing four skill sets with clear criteria and an online exam portal.

1.2 ECQA – European Certification and Qualification Association

A European certificate is also available for the above mentioned levels with the exam portal managed by the ECQA - European Certification and Qualification Association. The ECQA is a not-for-profit association which was created as a result of a number of EU-supported initiatives over the past ten years within which educational establishments decided to follow a joint process for the certification of individuals working within industry as part of the European Union’s Lifelong Learning Program.

The ECQA/LSSA exam guide can be downloaded at www.ecqa.org and at www.lssa.eu

2 Skill Definition Model

2.1 Skill Set Strategy

A skill set is a group of specific Learning Element that one should be able to apply within a certain job role. A standard group of skill sets within Europe is necessary due to the free mobility of workers. European countries such as the UK, The Netherlands, and France already have well-established open learning courses which support APL (Accreditation of Prior Learning). Within APL the skills of students are assessed, existing skills are recognised, and a learning plan is developed to cover any skill gaps. The skill assessment is based on defined skill units and a skill profile which indicates how many skill units have been covered.

LSSA has developed four skill sets that specify which of the overall Lean Six Sigma tools are expected to be included within a certain Belt level. A skill set is a group of 'Learning Elements' within eight 'Skill Units'. ASQ (American Society for Quality) Body of Knowledge [5], [6] documents were used as a baseline, and have been updated according the latest insights. Each of the 'Learning Elements' contains several 'Performance Criteria'. Each 'Performance Criteria' has an explanation and a cognitive level according to Bloom [8] which should be applied. The skill sets are used by the Examination Development Committee and to help candidates prepare for the exam.

2.2 Definitions

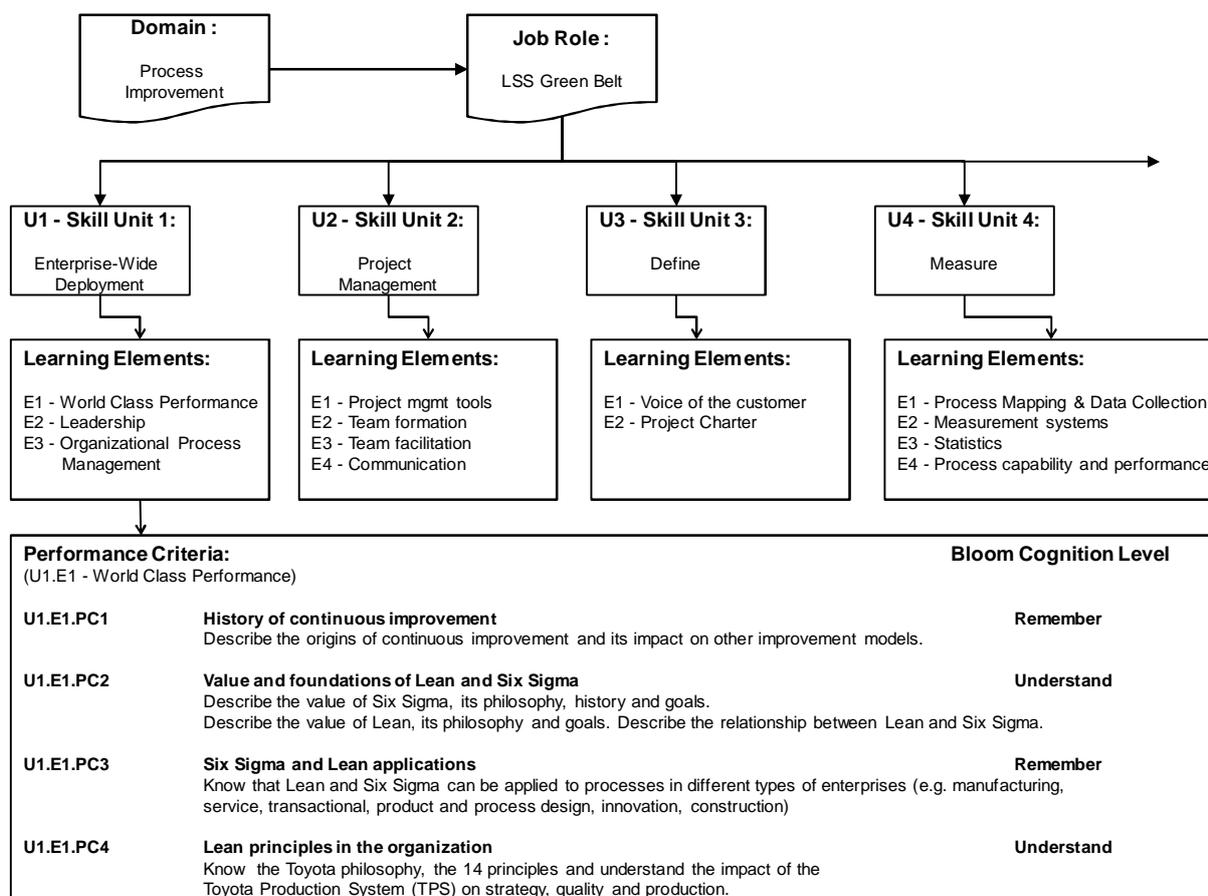
The skill sets are based on the skills definition proposed by the DTI (Department of Trade and Industry) in the UK for NVQ (National Vocational Qualification) standards [2] and revised skill cards from other countries. It contains the following items:

- **Domain:** An occupational category. E.g. Domain = Process Improvement.
- **Job role:** A certain profession that covers part of the domain knowledge. E.g. Job role = Yellow Belt, Orange Belt, Green Belt or Black Belt.
- **Unit:** A list of certain activities that have to be carried out in the workplace. It is the top-level skill in the qualification standard hierarchy. Each unit consists of a number of elements.
- **Learning element:** Description of one distinct aspect of the work performed by a worker, either a specific task that the worker has to do or a specific way of working. Each element consists of a number of performance criteria.
- **Performance criteria:** Description of the minimum level of performance a participant must demonstrate in order to be assessed as competent.
- **Level of cognition:** For each performance criteria there is an intended level of cognition. At the same time this describes the complexity level of the test questions for each performance criteria, according Bloom's Taxonomy – Rev. 2001.

2.3 Skill Set Structure

A skills hierarchy for the job role 'Lean Six Sigma Green Belt' has been designed using the terminology outlined in the skills definition model and includes the skills identified during the demand analysis performed at the beginning of the project.

In the graph below you will find an example for the first four Skill Units and their Learning elements. The first Learning Element of the first Skill Unit has three Performance Criteria, which are listed in the lower box. In total the Lean Six Sigma skill set for the 'Green Belt' job role is composed of 7 units; 21 learning elements and 95 performance criteria.



3 Green Belt Skill Set

3.1 U1 – Enterprise-Wide Deployment

The Unit ‘Enterprise Wide Deployment’ discusses the general philosophy of Process Improvement. It handles the overview of different process improvement methods and the history of the most important methods: Lean and Six Sigma. It also explains why process improvement is needed, how it is organised and the different roles and responsibilities involved.

3.1.1 E1 – World Class Performance

The Learning Element ‘World Class Performance’ explains the history, value and principles of Lean and Six Sigma. Similarities and differences to other improvement methods are also reviewed.

U1.E1.PC1	History of continuous improvement Describe the origins of continuous improvement and its impact on other improvement models.	Remember
U1.E1.PC2	Value and foundations of Lean and Six Sigma Describe the value of Six Sigma, its philosophy, history and goals. Describe the value of Lean, its philosophy and goals. Describe the relationship between Lean and Six Sigma.	Understand
U1.E1.PC3	Six Sigma and Lean applications Know that Lean and Six Sigma can be applied to processes in different types of enterprises (e.g. manufacturing, service, transactional, product and process design, innovation, construction).	Remember
U1.E1.PC4	Lean principles in the organization Know the Toyota philosophy and principles and understand how these directly apply to provision of timely, patient focused quality healthcare.	Understand

3.1.2 E2 – Leadership

The Learning Element ‘Leadership’ explains the roles and responsibilities of the people involved in process improvement. The different Belt-levels and roles of management, team leaders and team members are also reviewed.

U1.E2.PC1	Roles and responsibilities Describe Six Sigma levels of expertise: Master Black Belt, Black Belt, Green Belt, Orange Belt and Yellow Belt. Describe various team roles and responsibilities: Champion, Project leader, Supplier, User, Coach and Team member.	Understand
U1.E2.PC2	Change management Understand that there are different levels of change. Understand that change might cause resistance.	Understand
U1.E2.PC3	Team performance, evaluation and reward Esteem and value people in order to improve moral and commitment. Motivate team members and support their participation and commitment.	Apply

U1.E2.PC4	Organizational roadblocks Understand the impact an organizations culture and inherent structure can have on the success of Lean Six Sigma and how deployment failure can result from the lack of resources or management support. Know there are techniques to overcome these barriers.	Understand
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3.1.3 E3 – Organisational Process Management

The Learning Element ‘Organisational Process Management’ explains the business perspective of process improvement such as business performance and financial measures, benchmarking and customer survey’s. Project selection based on the above measures and project tracking is also reviewed.

U1.E3.PC1	Financial measures Understand financial measures, including cost of poor quality (COPQ), return on investment (ROI) and cost-benefit analysis.	Understand
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3.2 U2 – Project Management

The Unit ‘Project Management’ outlines the way improvement projects should be executed. It covers the most common project management tools, the DMAIC improvement roadmap and team facilitation.

3.2.1 E1 – Project Management Tools

The Learning Element ‘Project Management Tools’ sets out the main elements that have to be taken into account during project execution, such as differing interests of stake holders and project execution within time and budget.

U2.E1.PC1	Stakeholder analysis Identify process owners, internal and external customers and other stakeholders in a project. Understand different stakeholders have different goals.	Apply
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U2.E1.PC2	DMAIC roadmap Understand and follow the Process Improvement DMAIC roadmap. Identify and select the proper tools to use during the Process Improvement project.	Apply
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U2.E1.PC3	Time management Use project planning tools such as Gantt charts, critical path method (CPM) and program evaluation and review technique (PERT) charts. Attending meetings, arrive on-time, coming prepared. Be punctual and to the point. Able to define new actions.	Apply
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U2.E1.PC4	Project risk analysis and mitigation Describe the purpose and benefit of project risk analysis. Attending risk assessment and assure useful contribution by identifying risks.	Apply
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U2.E1.PC5	Project documentation Provide input and select the proper vehicle for presenting project documentation (e.g., spread sheet output and storyboards) at phase reviews, tollgate reviews or management reviews.	Apply
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3.2.2 E2 – Team Formation

The Learning Element ‘Team Formation’ discusses the various types of teams and the process for selecting team members.

U2.E2.PC1	Team member selection Understand the basic principles of team formation and team member selection.	Understand
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3.2.3 E3 – Team Facilitation

The Learning Element ‘Team Facilitation’ discusses the dynamics that can occur during a project such as cooperation, resistance, escalation of problems and solving roadblocks.

U2.E3.PC1	Team dynamics and performance Be constructive and pro-active. Looking for solutions rather than roadblocks.	Apply
U2.E3.PC2	Team stages Know that there are different stages in a project.	Remember
U2.E3.PC3	Team motivation Apply techniques that motivate team members and support their participation and commitment.	Apply

3.2.4 E4 – Communication

The Learning Element ‘Communication’ reviews the communication and decision making process within a team. The presentation of project progress is also reviewed.

U2.E4.PC1	Effective communication Use effective and appropriate communication for different situations to overcome barriers to project success.	Apply
U2.E4.PC2	Project progress and presentation skills Prepare presentation and present project results to others. Describe objectives achieved and apply lessons learned to identify additional opportunities.	Apply
U2.E4.PC3	Decision making Apply brainstorming, nominal group technique and multi-voting.	Apply

3.3 U3 – Define

Define is the first phase within the DMAIC roadmap. The Unit ‘Define’ discusses the elements that have to be taken into account during the first phase of a process improvement project such as the project charter and customer requirement.

3.3.1 E1 – Voice of the Customer (VOC)

The Learning Element ‘Voice of the Customer’ reviews customer requirements (internal/external) and the flow down of these requirements to measurable criteria for the product and/or process.

U3.E1.PC1	Customer identification Show how the project will impact customers. Identify internal and external customers.	Apply
U3.E1.PC2	Customer requirements Understand the experience of customers linked to product features described in the range from dissatisfied, expected, satisfied and desired quality levels (e.g. new KANO model).	Understand
U3.E1.PC3	Customer demand Calculate customer takt time. Distinguish between takt time and cycle time.	Analyse
U3.E1.PC4	Critical requirements (CTx) Define and describe various CTx requirements (critical to quality (CTQ), cost (CTC), process (CTP), safety (CTS) and delivery (CTD)) and the importance of aligning projects with those requirements.	Apply
U3.E1.PC5	CTx Flowdown Translate Voice of the customer (VOC) requirements into project goals and objectives. Translate objectives into CTx targets and specifications.	Apply

3.3.2 E2 – Project Charter

The Element ‘Project Charter’ covers the description of the project such as problem description, objectives, scope, timing and benefits.

U3.E2.PC1	Problem statement Develop and evaluate the problem statement in relation to customer requirements and business goals.	Create
U3.E2.PC2	Project scope and goal Develop and review project boundaries to ensure that the project has value to the customer (scope). Develop the objectives and measurable targets for the project based on the problem statement and scope (goal).	Analyse

U3.E2.PC3	Project performance measures Assist with the development of performance measurements (Cost, Quality and Delivery) and establish key project metrics that relate to the voice of the customer.	Analyse
U3.E2.PC4	Project benefits calculation Define and calculate the hard benefits of the project and describe the soft benefits of the project.	Apply

3.4 U4 – Measure

Measure is the second phase within the DMAIC roadmap. The Unit ‘Measure’ describes the measurability of the process/product responses and factors of influence. The Unit also reviews several process mapping methods, types of data and the reliability of the measurement method. This Unit also discusses statistics and visualisation of data.

3.4.1 E1 – Process Mapping & Data Collection

The Learning Element ‘Process Mapping & Data Collection’ sets out the different ways of process mapping to visualise the process. This Element also covers types of data and the accuracy and integrity of data.

U4.E1.PC1	Input and output variables (SIPOC) Identify input and output process variables and evaluate their relationships using PFM (Process Flow Mapping), SIPOC or Cause & Effect matrix.	Analyse
U4.E1.PC2	Process flow modelling and metrics Evaluate process flow and utilization to identify waste and constraints by analyzing work in progress (WIP), work in queue (WIQ), touch time, takt time, cycle time and throughput.	Analyse
U4.E1.PC3	Types of data Define and classify qualitative and quantitative data, continuous (variables) and discrete (attributes) data and convert attributes data to variables measures when appropriate.	Analyse
U4.E1.PC4	Sampling methods for assuring data accuracy and integrity Define and apply methods for collecting data such as check sheets and coded data. Apply appropriate sampling methods (e.g. random sampling, stratified sampling and systematic sampling) that ensure the integrity of data.	Apply
U4.E1.PC5	Measurement scales Apply and Analyse nominal, ordinal, interval and ratio measurement scales.	Apply

3.4.2 E2 – Statistics

The Learning Element ‘Statistics’ reviews the basics of statistics such as mean, deviation and probability. This Learning Element reviews a range of graphs that can be used to visualise data as well.

U4.E2.PC1	Basic terms Define and distinguish between population parameters and sample statistics (proportion, mean and standard deviation).	Apply
U4.E2.PC2	Visualization of data Construct and interpret diagrams and charts, including Pareto, Bar Chart, Pie Chart, Time Series Plot, Scatter Plot, Histogram, Box plot. Probability plot and Probability Distribution plot.	Analyse
U4.E2.PC3	Commonly used distributions Describe, apply and interpret the following distributions: Normal, Poisson, Binomial, Chi square, Student’s t and F distributions. Apply normality test (Anderson-Darling; Skewness and Kurtosis).	Analyse
U4.E2.PC4	Other distributions Know there are other distributions like exponential, lognormal and Weibull.	Remember
U4.E2.PC5	Descriptive statistics Calculate and interpret measures of dispersion and central tendency and construct and interpret frequency distributions and cumulative frequency distributions.	Analyse
U4.E2.PC6	Central limit theorem Describe and use the central limit theorem and apply the sampling distribution of the mean to inferential statistics for confidence intervals and control charts.	Apply
U4.E2.PC7	Basic probability concepts Describe and apply probability concepts such as independence, mutually exclusive events, and multiplication rules.	Apply
U4.E2.PC8	Drawing valid statistical conclusions Analyse enumerative (descriptive) and analytic (inferential) statistical studies and evaluate their results to draw statistical significant conclusions.	Analyse

3.4.3 E3 – Measurement Systems

The Learning Element ‘Measurement Systems’ examines the reliability of the measurement system.

U4.E3.PC1	Measurement methods Define and describe measurement methods for both continuous and discrete data.	Apply
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U4.E3.PC2	Measurement systems analysis Use various analytical methods (repeatability and reproducibility (R&R), correlation, bias, linearity, precision to tolerance, percent agreement and number of distinct categories) to analyse and interpret measurement system capability for variables and attributes measurement systems.	Analyse
U4.E3.PC3	Metrology Define and describe elements of metrology, including calibration systems, traceability to reference standards, the control and integrity of standards and measurement devices.	Understand
U4.E3.PC4	Measurement systems in the enterprise Identify how measurement systems can be applied in marketing, sales, engineering, research and development (R&D), supply chain management, customer satisfaction and other functional areas.	Understand

3.4.4 E4 – Process Capability and Performance

The Learning Element ‘Process Capability and Performance’ explains process capability and performance in relation to specification limits.

U4.E4.PC1	Process performance metrics Calculate process performance metrics such as percent defective, parts per million (PPM), defects per million opportunities (DPMO), defects per unit (DPU) and rolled throughput yield (RTY). Know the difference between a defect and a defective.	Analyse
U4.E4.PC2	Process capability studies Describe and apply elements of designing and conducting process capability studies, including identifying characteristics and specifications, developing sampling plans and verifying stability.	Analyse
U4.E4.PC3	Short-term and long-term capability Interpret the relationship between long-term and short-term capability.	Apply
U4.E4.PC4	Process capability indices Define, select and calculate Cp and Cpk to assess process capability.	Evaluate
U4.E4.PC5	Process performance indices Define, select and calculate Pp, Ppk and Cpm to assess process performance.	Evaluate
U4.E4.PC6	Process capability for attributes data Calculate the process capability and process sigma level for attributes data.	Apply

3.5 U5 – Analyse

Analyse is the third phase within the DMAIC roadmap. The Unit ‘Analyse’ reviews the analysis of current process performance. The different elements will review Risk Analysis, Root Cause Analysis, Waste Identification, Regression Analysis and Analysis of Variance.

3.5.1 E1 – Exploratory Data Analysis

The Learning Element ‘Exploratory Data Analysis’ describes the predictive models using regression techniques to determine the relation between factors on a response. This Learning Element also covers process performance metrics and the method for determining the capability of a process to meet specifications.

U5.E1.PC1 Regression analysis Apply
Calculate and interpret linear regression analysis and apply and interpret hypothesis tests for regression statistics. Use the regression model for estimation and prediction, Analyse the uncertainty in the estimate and perform a residuals analysis to validate the model.

U5.E1.PC2 Correlation coefficient Apply
Calculate and interpret the correlation coefficient. Determine its statistical significance (p-value) and recognize the difference between correlation and causation.

U5.E1.PC3 Analysis of variance (ANOVA) Apply
Define terms related to one-way ANOVA and interpret their results and data plots.

3.5.2 E2 – Hypothesis Testing

The Learning Element ‘Hypothesis testing’ reviews test methods that are used to test a hypothesis. This Learning Element also discusses Confidence Intervals that indicate the reliability of test conclusions.

U5.E2.PC1 Terminology Apply
Define and interpret the significance level, power, type I and type II errors of statistical tests.

U5.E2.PC2 Statistical vs. practical significance Apply
Define, compare and interpret statistical and practical significance.

U5.E2.PC3 Sample size Apply
Calculate sample size for common hypothesis tests (equality of means and equality of proportions).

U5.E2.PC4	Point and interval estimates/Confidence Intervals Define and distinguish between confidence and prediction intervals. Define and interpret the efficiency and bias of estimators. Calculate tolerance and confidence intervals.	Apply
U5.E2.PC5	Tests for means, variances and proportions Use and interpret the results of hypothesis tests for means, variances and proportions.	Apply
U5.E2.PC6	Paired-comparison tests Define and describe paired-comparison parametric hypothesis tests.	Understand
U5.E2.PC7	Goodness-of-fit (Chi square) tests Define and interpret chi square and use it to determine statistical significance.	Analyse

3.5.3 E3 – Analytical Methods

The Learning Element ‘Analytical Methods’ describes the tools that can be used for risk analysis, root cause analysis and waste identification.

U5.E3.PC1	Failure mode and effects analysis (FMEA) Describe the purpose and elements of FMEA, including risk priority number (RPN) and evaluate FMEA results for processes, products and services.	Analyse
U5.E3.PC2	Root cause analysis Define and apply root cause analysis, recognize the issues involved in identifying a root cause. Apply problem solving process and tools (5-Why and Cause and Effect diagrams / Ishikawa) for analysing problems.	Evaluate
U5.E3.PC3	Waste identification Identify and interpret the 8 types of waste (Overproduction, Waiting, Transport, Overprocessing, Inventory, Movement, Defects, Unused expertise).	Analyse
U5.E3.PC4	Value Stream Mapping (Current State) Distinguish value added from non value added activities. Apply Value Stream Mapping to construct a Current State Map of the process to identify waste and non value added activities.	Analyse

3.6 U6 – Improve

Improve is the fourth phase within the DMAIC roadmap. The Unit ‘Improve’ discusses the identification, implementation and verification of improvements that solve a problem, eliminate waste or improve quality or process performance.

3.6.1 E1 – Process Improvement Methods

The Learning Element ‘Process Improvement Methods’ sets out a series of methods and tools that can be used for process improvement, such as 5S, Kaizen, 8D, Theory of Constraints and Total Productive Maintenance.

U6.E1.PC1	Organized work environment (5S) Improve safety and moral. Organizing the work environment by applying 5S (Sort, Straighten, Shine, Standardize, Sustain).	Apply
U6.E1.PC2	Improvement teams (Kaizen) Able to facilitate improvement teams such as Kaizen or Small Group Activities.	Apply
U6.E1.PC3	Basic Problem Solving (8D) Familiar with the eight disciplines problem solving process which is used to approach and resolve problems.	Understand
U6.E1.PC4	Theory of constraints (TOC) Define and describe this concept and its uses. Identify bottle necks in the organization.	Analyse
U6.E1.PC5	Total Productive Maintenance (TPM) Understand the eight pillars of TPM and know how it can be used for process improvement.	Understand

3.6.2 E2 – Waste Elimination

The Learning Element ‘Waste Elimination’ discusses improving the organisation of a production line or process. This Learning Element also explains line balancing, Flow, Pull, quick change-overs and doing things right the first time.

U6.E2.PC1	Value Stream Mapping (Future State) Define a Future state map using Value Stream Mapping to eliminate waste and reduce cycle time.	Apply
U6.E2.PC2	Work and Line Balancing (Flow and Pull) Calculate and distinguish takt time and cycle time. Create a balanced process flow by levelling both volume and product mix. Implement Pull systems to avoid overproduction.	Apply

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| U6.E2.PC3 | Quick Change Over (SMED)
Support work and line balancing by reducing change over times by applying Single Minute Exchange of Die (SMED). Reduce materials, skilled resources and time necessary to equipment setup and product change over. | Apply |
| U6.E2.PC4 | First Time Right (FTR)
Understand the line has to be stopped when there is a quality problem. Identify opportunities to apply Poka Yoke to avoid quality problems. | Apply |

3.6.3 E3 – Design of Experiments (DOE)

The Learning Element ‘Design of Experiments’ reviews the design and evaluation of Full Factorial and Fractional experiments. These efficient experiments examine the influence of factors and interactions on a process.

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| U6.E3.PC1 | Principles of experiments and terminology
Describe and apply DOE principles and terms: Responses, Variables, Factors, Levels, Interactions, Balanced designs, Run Order, Randomization, Alias Table, Significance, Error and Residual analysis. | Apply |
| U6.E3.PC2 | Planning experiments
Plan, organize and apply experiments by determining the objective, selecting factors and responses. | Apply |
| U6.E3.PC3 | Full factorial experiments
Design, Analyse and interpret full factorial experiments. | Analyse |

3.7 U7 – Control

Control is the fifth phase within the DMAIC roadmap. The Unit ‘Control’ is about sustaining achievements and discusses the tools and procedures that ensure good quality. The elements that are reviewed include Statistical Process Control, Visual Management, Standardisation and Documentation.

3.7.1 E1 – Statistical Process Control (SPC)

The Learning Element ‘Statistical Process Control’ explains the controls methods used to identify out-of-control situations and deviations over time. Different types of SPC charts are reviewed.

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| U7.E1.PC1 | Objectives and benefits
Describe the objectives of SPC, including monitoring and controlling process performance and tracking trends. Apply SPC for reducing variation in a process. | Apply |
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U7.E1.PC2	Selection and application of control charts Identify, select, construct and apply the following types of control charts: Xbar-R, Xbar-S, individuals and moving range (ImR/XmR), median, p, np, c and u.	Apply
U7.E1.PC3	Control chart analysis Interpret control charts and distinguish between common and special cause variation using rules for determining statistical control.	Analyse
U7.E1.PC4	Selection of variables Identify and select critical characteristics for control chart monitoring.	Apply
U7.E1.PC5	Rational sub grouping Define and describe how rational sub grouping is used.	Understand

3.7.2 E2 – Quality Assurance

The Learning Element ‘Quality Assurance’ establishes a series of tools and procedures that can be used to measure, communicate and ensure quality such as visual management and controls.

U7.E2.PC1	Visual Management Apply the elements of Visual Management and describe how they can help to control the improved process.	Analyse
U7.E2.PC2	Control plan Develop a control plan to document and hold gains. Define controls and monitoring systems.	Apply

3.7.3 E3 – Sustain Improvements

The ‘Sustain Improvements’ Learning Element discusses methods for maintaining achievements, how to apply standardisation and how to become a learning organisation.

U7.E3.PC1	Lessons learned Identify and document lessons learned from all phases of a project. Identify possible improvements and ownership.	Apply
U7.E3.PC2	Standardized work and Documentation Standardize tasks and processes to establish the foundation for continuous improvement. Develop or modify documents including standard operating procedures (SOPs) and work instructions to ensure that the improvements are sustained over time.	Apply
U7.E3.PC3	Training deployment Support in developing work environment skills.	Apply

U7.E3.PC4	On-going evaluation and auditing	Apply
	Apply tools for the on-going evaluation of the improved process, including auditing (internal/external), monitoring for new constraints and identification of additional opportunities for improvement.	

3.8 U8 – Design for Six Sigma (DfSS)

The Unit ‘Design for Six Sigma’ is about applying Six Sigma tools in the product development process with the objective to design products and processes that will perform on a Six Sigma level from the earliest phase.

3.8.1 E1 – DfSS methodologies & Roadmap

The Learning Element ‘DfSS methodologies & Roadmap’ handles about the DMADV and IDOV roadmaps for product development. Additional tools are reviewed such as Quality Function Deployment, Reliability engineering and Tolerance analysis.

U8.E1.PC1	Road maps for DfSS	Understand
	Know DfSS roadmaps: DMADV (define, measure, Analyse, design, verify) and IDOV (identify, design, optimize, verify). Know how they relate to DMAIC and how they help close the loop on improving the end product/process during the design (DFSS) phase.	
U8.E1.PC2	Quality function deployment (QFD)	Remember
	Know QFD can be used into the DfSS process to translate customer requirements into performance measures.	
U8.E1.PC3	Design failure mode and effects analysis (DFMEA)	Understand
	Define and distinguish between design FMEA (DFMEA) and process (PFMEA) and interpret associated data.	
U8.E1.PC4	Design for X (DFX)	Understand
	Understand design constraints, including design for cost, design for manufacturability and producibility, design for test and design for maintainability.	

Appendix A – Bloom's Taxonomy for Performance Criteria

In addition to specifying content, each performance criteria in this skill set also indicates the intended complexity level of the test questions for each topic. These levels are based on “Levels of Cognition” (from Bloom’s Taxonomy – Revised, 2001), and can be used to create learning outcomes for students [7].

The Taxonomy of Educational Objectives, often called Bloom's Taxonomy, is a classification of the different objectives that educators set for students (learning objectives). The taxonomy was proposed in 1956 by Benjamin Bloom, an educational psychologist at the University of Chicago. During the nineties, Lorin Anderson a former student of Bloom revisited the cognitive domain in the learning taxonomy [8]. Bloom's Taxonomy divides educational objectives into three "domains": Affective, Psychomotor and Cognitive. This Skill only notice the Cognitive domain.

The ‘Levels of Cognition’ are in rank order - from least complex to most complex.

Remember

Recall or recognise terms, definitions, facts, ideas, materials, patterns, sequences, methods, principles, etc.

Understand

Read and understand descriptions, communications, reports, tables, diagrams, directions, regulations, etc.

Apply

Know when and how to use ideas, procedures, methods, formulas, principles, theories, etc.

Analyse

Break down information into its constituent parts and recognise their relationship to one another and how they are organised; identify sublevel factors or salient data from a complex scenario.

Evaluate

Make judgments about the value of proposed ideas, solutions, etc., by comparing the proposal to specific criteria or standards.

Create

Put parts or elements together in such a way as to reveal a pattern or structure not clearly there before; identify which data or information from a complex set is appropriate to examine further or from which supported conclusions can be drawn

Appendix B – European Qualifications Framework (EQF) for Job roles

The European Qualifications Framework (EQF) acts as a translation device to make national qualifications more readable across Europe, promoting workers' and learners' mobility between countries and facilitating their lifelong learning.

The core of the EQF are 'learning outcomes' which are eight reference levels describing what a learner knows, understands and is able to do. [8]

Level	Knowledge	Belt level
Level 1	Basic general knowledge	-
Level 2	Basic factual knowledge of a field of work or study	-
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	-
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study	Lean Six Sigma Yellow Belt
Level 5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	Lean Six Sigma Orange Belt
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Lean Six Sigma Green Belt
Level 7	<ul style="list-style-type: none"> Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research Critical awareness of knowledge issues in a field and at the interface between different fields 	Lean Six Sigma Black Belt
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	Lean Six Sigma Master Black Belt

Appendix B – Acronyms

Acronym	Description
APL	Accreditation of Prior Learning
ASQ	American Society of Quality
CREDIT	Accreditation of Skills via the Internet
YB	Lean Six Sigma Yellow Belt
OB	Lean Six Sigma Orange Belt
GB	Lean Six Sigma Green Belt
BB	Lean Six Sigma Black Belt
LSSA	Lean Six Sigma Academy, www.lssa.eu
NVQ	National Vocational Qualification standard of England, Wales and N. Ireland
EQF	European Qualifications Framework
ECQA	European Certification and Qualification Association, www.ecqa.org

The LSSA has developed an abbreviation list with over 200 Lean Six Sigma terms and abbreviations. It is available online in five different languages at www.lssa.eu.

Appendix C – References

- [1] *CREDIT Project*, Accreditation Model Definition, MM 1032 Project CREDIT, Version 2.0, University of Amsterdam, 15.2.99
- [2] DTI - Department of Trade and Industry UK, British Standards for Occupational Qualification, *National Vocational Qualification Standards and Levels*
- [3] R. Messnarz, et. al, *Assessment Based Learning centers*, in : Proceedings of the EuroSPI 2006 Conference, Joensuu, Finland, Oct 2006, also published in Wiley SPIP Proceeding in June 2007
- [4] Richard Messnarz, Damjan Ekert, Michael Reiner, Gearoid O'Suilleabhain, *Human resources based improvement strategies - the learning factor* (p 355-362), Volume 13 Issue 4 , Pages 297 - 382 (July/August 2008), Wiley SPIP Journal, 2008
- [5] American Society for Quality, *ASQ body of knowledge - Six Sigma Green Belt Certification*, 20-10-2008.
- [6] American Society for Quality, *ASQ body of knowledge - Six Sigma Black Belt Certification*, 20-10-2008.
- [7] European Certification and Qualification Association, *ECQA Guide*, Version 3, 2009, www.ecqa.org, Guidelines
- [8] Bloom, B.S., Engelhart, M.D., Furst, E.J., Hill, W.H. & Krathwohl, D.R. (1956). *Taxonomy of Educational Objectives, The Cognitive Domain*. New York: Longmans.
- [9] Anderson, L.W. & Krathwohl, D.R. (Eds.)(2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Longmans.
- [10] http://ec.europa.eu/education/lifelong-learning-policy/doc44_en.htm